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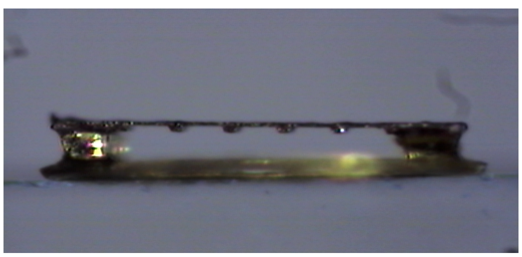
Rayleigh-Taylor Spike Evolution Experiment at Omega

Laser-based experiments have shown that Rayleigh-Taylor growth in thin, perturbed copper foils leads to a phase dominated by narrow spikes between thin bubbles. These experiments were well-modeled and diagnosed until this "spike" phase, but not into this spike phase. We have designed, modeled, and performed experiments on the Omega laser to study the late-time spike phase.

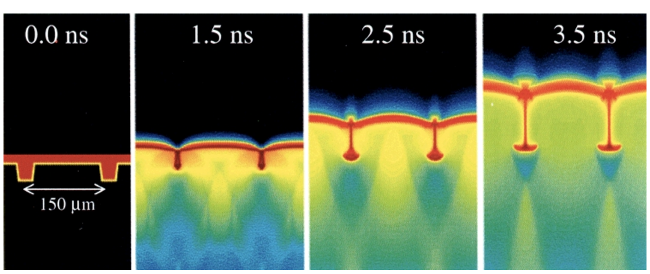
To simulate this late time R-T condition we milled a copper target generating a series of 10-20 µm thin, 200 µm-long, 30 µm high ridges 150 µm apart leaving a thin flat copper backing. The target was placed on the side of a scale 1.2 Omega laser hohlraum with the ridges pointing into the hohlraum. A laser drive consisting of 1-ns square pulses heated the hohlraum to 190 eV. to ablatively drive the target.

The picture below shows the side-on view of such a target on a slotted washer. This structure gets mounted over a hole in the hohlraum with the ridges facing the radiation drive through the slot in the washer.



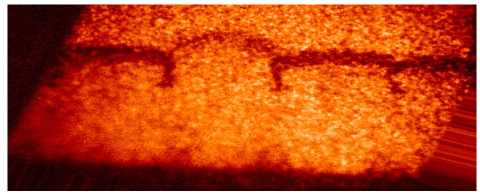
The spike evolution was modeled. The RAGE code was used because its continuous adaptive-mesh refinement scheme always puts zones near the evolving perturbations, independent of the shape taken by that perturbation. The results are shown below. The images represent the transmitted x-ray flux at 6.7 keV as would be generated from an iron backlighter behind the target. The time sequence clearly shows the spike evolution and bubble formation and the flow of the ablated plasma leading to the 'mushroom' formation on the spike tips at late times. The whole structure moves away from the hohlraum

The OMEGA experiment used side-on radiography with a 6.7 keV iron



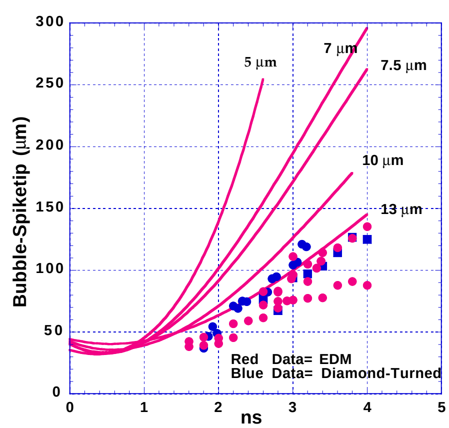
backlighter source. A gated x-ray imager at magnification 12 gave 16 time-resolved transmission images from which the temporal development could be obtained.

The picture below shows such a typical radiograph at about 3 ns.



One clearly sees the growth of the spikes and the 'mushroom-like feet' on the tips of the spikes. It appears that this particular target had a non-uniform thickness of the backing since neighboring cycles show a different behavior. The beautiful plasma flow between the cycles as shown in the simulations is not obvious. Signal to noise in the images and insufficient contrast for the x-ray transmission through this flow could be the cause.

The figure below shows the comparison between the simulation for several backing thicknesses and the data. The bubble-spike distance is measured from the tip of the spike to the back of the bubble.



Two processes were used to produce the targets, diamond turning (DT) and electric discharge machining (EDM). The DT targets had a 4-7 µm backing whereas the EDMs a 10-12 µm backing. The RAGE predictions are in reasonable agreement with most of the EDM targets (red) assuming a lower drive temperature of 173 eV. This may be within the error of Dante temperature measurements. The discrepancy with the DT target data (blue) is not yet understood.

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